

Study on standardization for Interoperable Metaverse

Wook Hyun*

*ETRI (Electronics and Telecommunications Research Institute), Republic of Korea

whyun@etri.re.kr

Abstract— The rapid development of artificial intelligence, blockchain, and networks, and the sudden appearance of the metaverse, triggered by COVID-19, are both expected and concerned. Along with criticism that it is somewhat exaggerated, it is receiving a lot of attention in that it can provide a foundation for social and economic activities in the virtual world. In this paper, we present the new driving force that re-emerged the metaverse, and analysis on the related standardization status. By the analysis on that, we propose the interface and interworking model required to make the metaverse interoperable with each other.

Keywords— metaverse, standardization, interoperability, interoperable metaverse, interaction model

I. INTRODUCTION

Since the term metaverse first appeared in the 1992 American novel 'Snow Crash'[1], it stayed in the realm of fantasy such as a three-dimensional virtual world in various movies, and gradually moved to the realm of reality as technology developed. After that, in 2007, the Acceleration Studies Foundation (ASF)[2] published a roadmap[3] analysing the four major types of metaverse: augmented reality, mirror world, lifelogging, and virtual world.

In the 2010s, technology development and standards for immersive media began to be developed, and with the advent of VR(Virtual Reality), AR(Augmented Reality), and MR(Mixed Reality), a more realistic metaverse became possible. However, even up to this stage, the metaverse did not stay at the level of a simple experimental or independently driven application. Through the rapid development of blockchain and artificial intelligence that started in the late 2017, various global big companies are jumping into it with the vision that the connected virtual world will become another world where social change and economic activity are possible, not just a virtual experience.

In other words, if the metaverse discussed previously was just a metaverse of a simple virtual experience space, the metaverse that is being talked about today is coming closer to include a new virtual world, that is, a social and economic ecosystem in the virtual world.

In this paper, we describe the new driving force that brought back the metaverse in clause 2, we classify the two types of major interfaces for the interoperable metaverse. Also, we describe the latest standardization trends regarding interoperable metaverse in clause 3. We describe three interoperable implementation models in clause 4, and conclude this paper in clause 5.

II. NEW DRIVING FORCES OF THE METAVERSE

The new driving force that can make the metaverse a reality is technological developments such as blockchain, artificial intelligence, and network development, and rapid social changes due to COVID-19.

A. Blockchain and NFT

The first-generation blockchain such as Bitcoin only supported the movement of simple assets, but the advent of Ethereum, the second-generation blockchain capable of smart contracts, opened a way for blockchain to be used in various fields. In particular, various ERCs(Ethereum Request for Comment) based on Ethereum have been proposed, and NFT(Non-fungible token) is specified in ERC-721[4]. NFT is useful for expressing digital assets on the metaverse, and since the interoperability of the economic system on the metaverse can use blockchain, it will not be possible to talk about the blockchain without discussing the interoperable metaverse.

In particular, it is noteworthy that when an NFT is minted for the first time, a certain portion of transaction fee can be charged to contents creators or artists whenever NFT assets are traded. This feature will give a motivation to metaverse platforms to make their contents to be shared with other platforms. As metaverse platform assets or content are made into NFTs and interoperability with other platforms is expanded, the NFTs issued by them will be traded naturally. This will be a cash cow for platform providers, and will strive not to damage the balance and value within the platform for active trading of NFTs issued by them.

It is not possible to achieve interoperability with all metaverse platforms in a single moment. In the initial stage, metaverse platforms (mainly game platforms) will partially promote item compatibility by agreement with each other. This agreement may include transformations of attributes and functions of items, including shapes within each platform. This is necessary to prevent the platform from collapsing due to external items. In the long term, with the advent of intermediary service providers rather than bilateral agreements, it can be considered to spread to a model that participates autonomously in accordance with a predefined protocol without a separate agreement.

B. Artificial Intelligence

Technological advances in NLP(Natural Language Processing) have been achieved with the advent of hyperscale AI. Because of this, NPCs(Non-player character) can also be given intelligence rather than simply repeating scripted

sentences. With a super-giant AI, it is possible to create human-like sentences with just a few prompts, and it can also create various styles, dialects, and even speaking styles.

In addition, the emergence of a photo-realistic digital human is not only maximizing the sense of realism, but also building a fandom with thoroughly planned virtual characters. Of course, most of the things except for the movements of digital humans are done by humans directly from behind, but in the near future, it is expected that it will be able to position itself as a virtual person that moves completely independently in combination with a hyperscale AI.

C. Network – 5G, MEC

5G technology that can provide ultra-low latency and ultra-high-speed transmission for real-time immersive service and provide sophisticated user location information can enable real and virtual synchronization. Even if users of application services combined with MR (Mixed Reality) function and LBS (Location based service) are concentrated in the same area at the same time, it is possible to predict or distribute the load in advance with MEC (Multiaccess Edge Computing) technology. From the network point of view, it is judged that the requirements for the metaverse are sufficiently satisfied.

In an article [5] published in April 2022, it lists up several requirements for Metaverse such as ubiquitous access, lightweight and accessible XR devices, cloud and edge-cloud (MEC) capabilities, standardized interfaces, easy access to communication services for developers, and it describes how 5G can meet these requirements.

D. COVID-19

It is very ironic, but the world of non-face-to-face society is rapidly approaching. If it were not for the COVID-19 situation, the social changes that would have taken place over decades have occurred in a short time of two or three years.

For video conferencing services, the representative non-face-to-face service, according to Globe Newswire, there was a 48% increase over pre-COVID-19 pandemic, and for Zoom, there was a 535% increase in traffic in 2020 compared to 2019. The \$6.03 billion market in 2021 is expected to grow to \$50 billion by 2026 [6]. In addition, according to a survey published by Statista[7] in 2022, 92.16% of respondents said that the pandemic drove the development of metaverse technology.

III. CLASSIFICATIONS OF METAVERSE INTEROPERABILITY

Interoperability of metaverse can be broadly classified into two types: vertical interworking and horizontal interworking. Through horizontal interworking, the metaverse platform interacts with other metaverse platforms or 3rd party service platforms, and synchronization with the physical world can be achieved through vertical interworking.

A. Horizontal interworking

Horizontal interworking can be seen as a way for users to seamlessly move and experience multiple metaverse platforms.

For this, content, real-time events, user profiles, device profiles, etc. need to be exchanged. With the development of blockchain and the advent of the concept of NFT, public

assetization of items and proof of ownership are possible, so it can be seen that the foundation has been laid for various metaverse service platforms to be freely used without being dependent on a specific platform. Figure 1 shows the concepts of horizontal interactions for interoperable Metaverse.



Figure 1. Horizontal interfaces for Interoperable Metaverse

B. Vertical interworking

Vertical interworking is mainly for synchronization between the real world and the virtual world as shown in Figure 2.

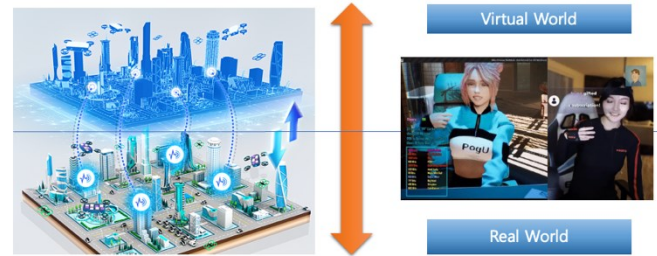


Figure 2. Vertical interfaces for Interoperable Metaverse

Digital twin and virtual broadcasting are representative examples. Digital twin is a technology that builds a virtual world based on sensed information in the real world, and can deal with what will happen in the real world through simulation in the virtual world. It is a technology mainly used in industry and is being widely used in logistics and smart factories due to the recent development of artificial intelligence. In the case of virtual broadcasting, information on a user's facial expression, gesture, etc. is mapped to a character in the virtual world as it is, so that it can have a very natural motion. Currently, the focus is mainly on reflecting real world information into the virtual world, but it is expected that changes in the virtual world will be reflected in the real world soon. It has already been generalized to some extent in the game domain, such as force feedback and vibration.

IV. STANDARDIZATION ACTIVITIES ON INTEROPERABLE METAVERSE

Seamless interoperable Metaverse can be realized through the vertical and horizontal interworking described in Section 3.1. In this section, metaverse inter-operability for horizontal compatibility and intra-operability standardization trend for vertical compatibility are described separately.

A. Standardizations on horizontal interoperability

Various standardization organizations such as W3C, Khronos Group, Metaverse Standards Forum, and Open Metaverse Interoperability group are actively discussing securing metaverse interoperability.

1) Metaverse Standards Forum: The *Metaverse Standards Forum (MSF)* was established in June 2022 to provide a method for cooperative discussion among various standardization organizations. Standard organizations such as *W3C*, *Khronos Group*, *OpenAR*, *OpenGeo*, and more than 1,500 organizations are participating in this forum. This forum aims to provide opportunities for collaboration to gather use cases and requirements to ensure metaverse interoperability, coordinate work with existing SDOs, develop hackathons, plug test tools, and consistent terminology and deployment guidelines. *MSF*'s main activity goal is to "resolve the lack of interoperability that hinders the spread of metaverse through work coordination with existing SDOs", and does not plan to develop its own standards [8].

2) Open Metaverse Interoperability Group: This group was established in April 2021 and aims to develop protocols to connect virtual worlds. Although the specific standardization scope has not been determined, it is roughly aimed at identity, social graph, inventory, trading, avatars, 3d content, portable scripted object/scene, etc. In addition, *W3C MICG* will play the role of *W3C* standardization of specifications made by *OMI Group*.

3) W3C relevant CGs: The *W3C* currently has three Metaverse-related Community Groups (CGs). Anyone can establish CG, but CG is a group that can develop its own specifications but cannot develop standards. Therefore, the specifications developed in CG are transferred to the WG composed of *W3C* members for standardization or a new WG can be newly established and discussed. Currently, among the three WGs, *Virtual Reality website* and *Metaverse CG*, established in 2015, are almost inactive. In addition, *Galaxy Metaverse CG*, established in January 2022, plans to discuss virtual world infrastructure, virtual land management, marketing, avatar communication, and goods. It is difficult to see that all three CGs of the *W3C* are actively standardizing at the moment, but it is expected to become one of the most powerful standardization organizations when the web-based metaverse becomes full-fledged in the future.

- *Metaverse Interoperability Community Group*
- *Galaxy Metaverse CG*
- *Virtual Reality website and Metaverse*

4) ITU-T CG-Metaverse: This group was newly established at the *SG16* meeting in January 2022, is developing a technical report based on the results of discussion on the analysis of metaverse standardization technology trends and the establishment of strategies for deriving metaverse standardization items. Currently, *CG-Metaverse* is discussing metaverse use cases, interworking requirements, and ToR of a new focus group. Based on the CG report, *ITU-T SG16* and *TSAG* will decide in December 2022 whether or not to establish a new focus group.

B. Standardizations on vertical interoperability

Vertical interoperability, which mainly connects the physical world and the virtual world, can be achieved by securing

standards related to interactions within one metaverse platform. This section describes the related standardization trend.

1) MPEG: *MPEG-V(MPEG-Visual)*, *ISO/IEC 23005 Media context and control standard*, which can be the beginning of metaverse standardization, was developed in MPEG. MPEG-V standardization started in 2008 stipulates data to be exchanged on the interface between the real world and the virtual world for the purpose of standardizing 4D sensorial effects and virtual worlds (Metaverse). *ISO/IEC 23005* consists of a total of 7 parts, and Part 4 related to the metaverse defines the virtual world object characteristics. This standard describes the operation and data for Real-To-Virtual, Virtual-To-Real, and Virtual-to-Virtual. Metadata for avatars that are closely related to the metaverse are also defined. MPEG-V standardization ended in the first half of 2010, and the MPEG IoMT group is currently developing a standard that defines an API for communication in media devices.

2) IEEE: *IEEE 2888 WG* (Interfacing Cyber and Physical World WG) was established in September 2019. The scope of the main standard defines the interface between physical and virtual objects, the vocabulary for exchanging sensor information, requirements, and data format. The standards developed by this group are mainly for the control of sensors and actuators required for synchronization between the virtual world and the real world for digital twins. There are 6 projects are under operational (*IEEE2888.1 ~ IEEE2888.6*).

3) Others: In relation to other technologies expected to be used in metaverse, XR, MR, and VR related standards are being developed in *W3C WebXR/WebVR*, *IEEE 3079/3079.2*, *JTC1 SC24 WG11*, etc.

V. METAVERSE INTEROPERATION MODEL

This clause describes the metaverse interworking model by classifying it into a metaverse service provider(platform) and a metaverse application(client).

A. Direct interaction model between MSPs

This model exchanges information for avatar movement, content reuse, and item compatibility between MSP (Metaverse Service Provider) platforms as shown in Figure 3.

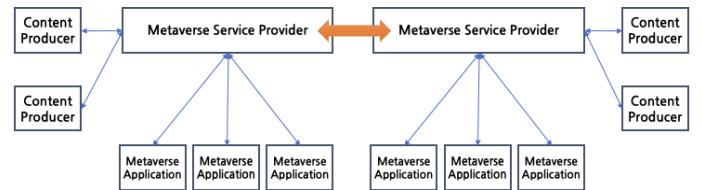


Figure 3. Metaverse platform direct interaction model

However, in this case, the MA is highly likely to operate in a manner dependent on a specific MSP, so if it moves to another metaverse, it will operate according to the restrictions in the new metaverse. Although seamless compatibility between MSPs is difficult for this model, it has the advantage of being more specialized and providing a highly realistic experience through maximum performance utilization. This model defines

compatible information and conversion rules through an agreement between metaverse platform providers. For example, an avatar moved through a portal between metaverses will be converted into an avatar provided by the newly moved metaverse, and previously owned attribute values will also be converted and applied.

B. Indirect interactions model through MISP

In contrast to the method presented in clause 3.2, the conversion is accomplished through bilateral agreement, this model uses a rule-based conversion method by a MISP (Metaverse Integration Service Provider).

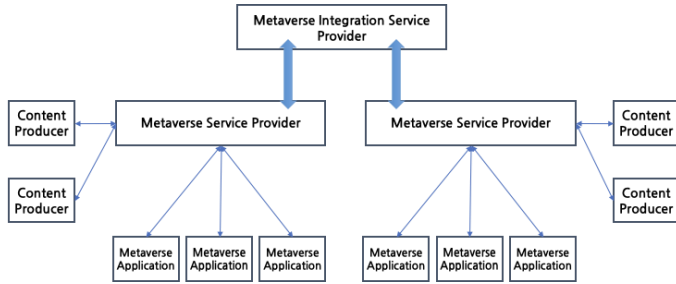


Figure 4. Metaverse platform interoperation model through MISP

MISP is located between metaverse platforms and acts as a kind of gateway or clearing house as shown in Figure 4.

C. General purpose client model

This model is a method in which one general-purpose MA (Metaverse Application) client connects to several MSPs, and I think it is the most effective and direction to go in the long term as shown in Figure 5. In this case, the user does not need to be belong to any platform, but have full access rights on their data to be stored into blockchain.

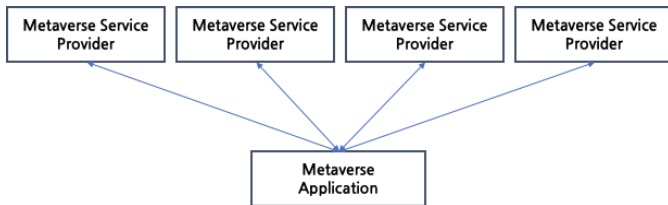


Figure 5. General purpose MA and metaverse platform interaction model

This general-purpose client is very likely to be a web browser. In particular, the W3C is continuously developing technologies that can provide high performance through the support of *WebXR* and *WebVR* as well as *WebAssembly* and *WebGPU*. In particular, *WebGPU* shows a brighter future in terms of being able to extract high performance by directly accessing GPU resources from the JavaScript code of the web browser by inheriting the *WebGL* and *WebGL2* graphics APIs. However, since it is still in the standardization stage without official browser support, it is difficult to use these technologies yet, but it is a competitive technology from a long-term point of view.

VI. CONCLUSIONS

It can be said that the possibility of realization of the metaverse is stronger than ever due to various technological and social conditions, but there is also an aspect that it bloomed early in a state where it was not technically ready enough to meet users' expectations. It will take quite a long time for the Interoperable Metaverse to become a reality and be used in daily life, the existing technological, social and economic barriers will disappear through various innovations, and companies armed with feasible products and services will dominate the market with greater power. From the perspective of the metaverse as a virtual world, AR and VR technologies are necessary to provide realistic immersive elements, but they are not indispensable technologies in the metaverse ecosystem. The true value of Metaverse will be revealed only when an ecosystem that enables social and economic activities in the virtual world is established. In order for these social and economic activities to be carried out seamlessly in the virtual world and to form a huge metaverse ecosystem, the role of standards is very important, and it is necessary to approach it from a long-term perspective through close discussions between companies and standardization groups in various fields.

In this paper, we presented the metaverse platform interworking model along with the classification of horizontal and vertical interactions for Interoperable Metaverse as well as the analysis on the standardization trend related to metaverse.

ACKNOWLEDGMENT

This work was supported by Institute for Information & communications Technology Promotion (IITP) grant funded by the Korea government (MSIP) (2022-0-00392, Development of standards on reference architecture for service interoperability of Metaverse platform)

REFERENCES

- [1] Neal Stephenson, "Snow Crash", Del Rey Books, June 1992
- [2] Acceleration Studies Foundation, <https://www.accelerating.org/>
- [3] Smart, J.M., Cascio, J. and Paffendorf, J., "Metaverse Roadmap Overview", 2007
- [4] William Entriken et al, "ERC-721: Non-Fungible Token Standard", ERC-721, June 2018
- [5] Yashar Nezami et al, "What is the metaverse and why does it need 5G to succeed? The metaverse 5G relationship explained", April 2022, <https://www.ericsson.com/en/blog/2022/4/why-metaverse-needs-5g>
- [6] Straits Research, "Video Conferencing Market Size is projected to reach at a CAGR of 15.45% during the Forecast Period: Straits Research", July 2022, <https://www.globenewswire.com/en/news-release/2022/07/19/2482223/0/en/Video-Conferencing-Market-Size-is-projected-to-reach-at-a-CAGR-of-15-45-during-the-Forecast-Period-Straits-Research.html>
- [7] Statista, "Did the pandemic accelerate metaverse technology?", Apr 2022, <https://www.statista.com/statistics/1302264/metaverse-acceleration-due-to-covid-19/>
- [8] Metaverse Standards Forum, <https://metaverse-standards.org>



Wook Hyun is a research staff member with ETRI (Electronics and Telecommunications Research Institutes) since 2000. He has received M.S. degree in Information Communication Engineering from Chungnam National University, Korea in 2000. His research interests include VoIP, SIP, NGN, P2P, overlay networking, digital signage, AI, Blockchain and Metaverse